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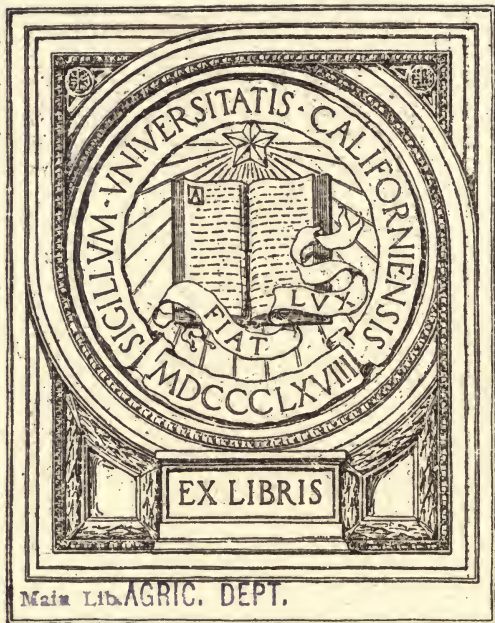
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NITRATE OF SODA  
FOR PROFIT WITH  
SUGAR - BEETS

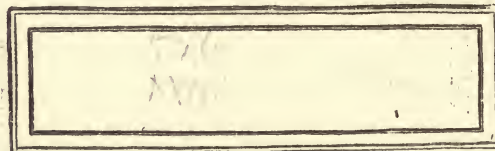
NITRATE OF SODA PROPAGANDA

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# **Nitrate of Soda**

**For Profit With**

# **Sugar-Beets**

**Maercker**  
**With Supplements**  
**by**  
**Danielson**  
**Colorado Experiment Station.**

**EDITED AND PUBLISHED BY**  
**WILLIAM S. MYERS, Director,**  
**Nitrate of Soda Propaganda.**  
**Late Professor in Chemistry in the State Agricultural College of New Jersey.**  
**JOHN STREET AND 71 NASSAU, NEW YORK.**



**T**HE Nitrate Propaganda is not engaged in the Sale of Nitrate of Soda but will furnish a list of dealers to all who apply for it.

It should be remembered that the original package of Nitrate of Soda contains approximately 200 lbs. of normally dry Nitrate of Soda.

Nitrate of Soda is generally sold in the original packages and should be stored or kept in a dry place. Glass Works and Manufacturers of Dynamite and Gunpowder usually have Nitrate on hand.

If you have any difficulty in obtaining Nitrate, either by reason of prohibitive prices or undue delays or on account of inability of dealers to supply you promptly, let me know at once, and the difficulty will be investigated immediately.

Correspondence concerning excessive freight charges is invited. Nitrate is sometimes discriminated against by the Transportation Companies by charging a chemical rate instead of a fertilizer rate; please secure and forward all the facts, including Freight Receipts.

When ordering Nitrate, please be sure to request your Dealer, Manufacturer or Importer to have your invoice clearly and distinctly marked as "Fertilizer." This is necessary that this valuable Farm Chemical may be properly classified in order to avoid the discrimination practised by the Railroads against Nitrate.

**WILLIAM S. MYERS, Director**

**NITRATE PROPAGANDA**

**John Street and 71 Nassau, New York**

# NITRATE OF SODA

## FOR PROFIT WITH SUGAR-BEETS

By Maercker  
With Supplements  
By Danielson,  
of the Colorado Experiment Station

BULLETINS OF U. S. EXPERIMENT  
STATIONS

Abstract of Bulletin No. 115  
of the Colorado Station  
By Danielson.



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## Preface.

The following leading Authorities, among others, have been consulted in the preparation of this work.

1. Dr. Maercker, Government Privy Councillor, German Agricultural Association.
2. *Fertilizer Experiments*; Colorado Agricultural Experiment Station, Abstract of Bulletin No. 115, by A. H. Danielson.
3. *Sugar-Beet Investigations*; Michigan Agricultural Experiment Station, Bulletin No. 179, by J. D. Towar.
4. *Effect of Each Class of Fertilizer*; Nebraska Agricultural Experiment Station, Extract from Bulletin No. 73.
5. *Fertilizers for the Sugar-Beet*; from "*The American Sugar-Beet Industry*," 1906.
6. *Sugar-Beet Investigations*; Ohio Agricultural Experiment Station, Bulletin No. 132.
7. *Progress of the Beet Sugar Industry in America*; from Report No. 80, Bureau of Plant Industry, United States Department of Agriculture. C. O. Townsend.
8. *Experiments with Nitrate of Soda*; by Dr. Paul Wagner.
9. Farmers' Bulletin No. 52, United States Department of Agriculture.

New York, January, 1907.



# The Profitable Cultivation of the Sugar-Beet and Other Crops by the Use of Nitrate of Soda.

## The Functions of Nitrate of Soda in Sugar-Beet Growing.

Extracts from a Lecture, delivered by Dr. Maercker, Government Privy Councillor, German Agricultural Association, on the Profitable Cultivation of the Sugar-Beet and Other Crops by the use of Nitrate of Soda.

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It is always a great pleasure to me when I have the opportunity of going into a new district and thereby extending my own sphere of knowledge; for I go outside my own circle, not only with the object of imparting something, but also of, at the same time, bringing something away with me; and frequently, when a lively discussion has taken place upon a question which I have introduced, I have returned home with the consciousness that I have brought away from the meeting more than I took to it. Now, in order to be able to offer you perfectly definite advice, it is necessary to know accurately your agricultural position, and to be thoroughly acquainted with your conditions of soil and climate, so as to be able to form an adequate judgment regarding them. That is denied to me, because I am a stranger in your district, and this fact places me in some embarrassment and renders it possible that objections may be taken to what I am about to say to you, although I shall do my utmost to be as guarded as possible. But such objections will not be unfruitful, for I myself will learn something from them, and I shall endeavor to improve, what is capable of improvement, in your methods.

Introduction.

It is very opportune that you should have chosen as the subject for consideration at to-day's meeting the cultivation of the sugar-beet, and the use of Nitrate of Soda, which is inseparably connected with the cultivation of the sugar-beet; because, in fact, circumstances at the present time are such

Inseparable  
Connection of  
Culture of  
Sugar-Beet and  
Nitrate.

that, with the exception of cattle breeding and cattle dealing—and even in that branch retrogression has of late been observable—agriculture has become so little remunerative that farmers have almost lost heart, and the cultivation of the sugar-beet is the only resource that is left to us. We would, therefore, hope that, by an intelligent adoption of the new sugar-duty law, those parts of the country in which the cultivation of the sugar-beet, although they are suited for it, has not yet attained due development, will have the possibility



A Field of Young Beets on the Upper Gila in Graham County,  
After Thinning, April 22, 1901.

Bulletin No. 51, Arizona Experiment Station—Mc Clatchin—Fabbs.

open to them in future of taking it up to the fullest extent. The prospects of the law passing are, it may be said, not unfavorable; they have, so far as I can learn in Reichstag circles, distinctly improved of late, as regards the grants which are to be made and which will allow of the establishment of new factories to a wide extent. We, in the province of Saxony, in no way take up a narrow-minded position; we know what advantages the cultivation of the sugar-beet confers on agriculture generally, and we are far from wishing that you



should not share in those advantages. On the contrary, we shall rejoice to see our fellow-agriculturists in the east participate in the blessings of the sugar-beet industry.

Gentlemen, after these introductory remarks, I pass on to my proper theme, and I shall first of all have to discuss what is requisite generally for the remunerative cultivation of the sugar-beet.

*The first requisite is a suitable climate.*

Climate.

Upon this I do not need to enlarge, for you are in the midst of sugar-beet growing districts, and your climate will not essentially differ from that in which the sugar factories of Culmsee, Kruschwitz, Nakel, Wreschen, and others, have called into existence a remunerative cultivation of the beet. There can be no question that your climate is just as well suited to its remunerative cultivation, and to the production of beets as rich, if not richer, in sugar. Your climatic conditions, indeed, are such that you have a later spring. According to the data with which Major Hintze has furnished me, it may be taken that spring commences with you about ten days later than with us; but you make up for that afterwards by a hotter sun and a higher summer temperature; and there can be no doubt that just this temperature exercises a very favorable influence upon the contents of the beet in sugar; so that, here in the east—although we formerly doubted it—you are able to produce beets which are not only not poorer in sugar than in the neighboring districts for which a monopoly of the cultivation of the crop was once claimed, but beets which are probably even somewhat richer in sugar, and which, in any case, possess as high a percentage of sugar as any factory can require; so that the question of climate is completely disposed of.

*In the second place, there must be available the kind of soil suitable for the cultivation of the sugar-beet,* and we shall therefore have to enter upon the discussion of the question: What is essentially the best soil for beets?

Gentlemen, if you put this question to me, I am in a difficulty as to what reply to make. For our ideas as to the necessary qualities of a soil for the growth of the sugar-beet have changed during the last ten years in a remarkable manner. Formerly we believed that we should never be

Best Kind of  
Soil.



able to grow beets, and especially beets rich in sugar, on any other kind of soil than light loam rich in humus, such as we have in the Magdeburg district, on the northern border of the Harz, and in parts of Brunswick and Hildesheim. But when later on land owners felt the need of giving their acres a rest from beet-growing, they gradually extended their beet cultivation to the lighter soils; they turned from the essentially loam soils first to the sandy loams, then to the loamy, and lastly to the light sandy soils; and, in fact, on these last, if they only possess the necessary moisture and are properly manured, we succeed in growing as good beets as on loam, so that we may say that the type of soil suitable for growing beets is by no means a restricted one, but that any even moderately useful agricultural land appears to be suited for the cultivation of the crop. At most we might exclude heavy clay soils, which are certainly least adapted to the growth of the sugar-beet; but, if the necessary means are employed, even they may be rendered suitable; the means consisting mainly in the systematic employment of lime to modify the heavy nature of the clay soil so as to allow the beet to root deeply, to warm the soil, and to render it readily workable. *If this be done, sugar-beet cultivation may be profitably carried on even on the heaviest clays.* This has been proved in the most convincing manner, and we therefore arrive at the conclusion that there is, in fact, no kind of soil, with the exception of the driest sand drifts, on which the sugar-beet may not be successfully cultivated, if we only understand what are the measures necessary to make it thrive.

#### Sub-Soil.

*If I now pass on to the third requisite for sugar-beet cultivation, it urgently requires both a warm soil and a warm sub-soil.* If we wish to define what constitutes a cold soil, we understand by a cold soil one in the sub-soil of which there is stagnant moisture, water which has no outflow. The water causes coldness, and cold is the greatest enemy of the sugar-beet, for it both diminishes the quantity and injures the quality of the crop in an incalculable degree. It is, in fact, correct to say of such a soil that it is unsuitable for the cultivation of the sugar-beet. But it must by no means be assumed that such a soil is wholly and forever unfit because it is less suitable than a soil with a warm, well drained sub-soil.

*A further requisite, absolutely essential in the case of soils where there is stagnant moisture in the sub-soil, is, therefore, the carrying out of judicious drainage.* You must not think, gentlemen, that the prize has fallen to us, who are in the center of the beet cultivation, all at once and without exertion; on the contrary, it has required hard and tedious work to enable us to reach the position which we have now attained, and, with us, drainage, wherever necessary—and it has been necessary in very many places—has long since been carried out, and with most beneficial results, not only to beet growing, but also in the case of other field crops.

Now, I am unacquainted with the conditions in which you are farming here, and I do not know whether drainage is extensively required; but I cannot divest myself of the impression that your soil is in many places in great need of drainage. Wherever we see water standing in the hollows of the fields, we may be quite sure that there is need for drainage, and that, if the necessary means are at disposal, drainage work should be carried out without delay. It may probably not always be a question of systematic drainage of the entire field, but only of those places where it is absolutely necessary that the water should be carried off. In all probability you will secure good results if you thus effect partial drainage; but I must lay down, as an indispensable requisite of sugar-beet growing, that, if there be to any great extent stagnant moisture in the sub-soil, thorough drainage must be carried out.

#### Drainage.

*A further and, indeed, the most important condition of all for the successful cultivation of the sugar-beet is the presence of a sufficiency of lime in the soil;* without this, the hope of a good and profitable yield of sugar-beets would be difficult of fulfillment. But this evil is easily to be remedied; for, if there be not sufficient lime present in the soil, it can easily be furnished by judicious liming; and even in our district, where the cultivation of the sugar-beet has been very successfully carried on, the requisite store of lime was not always at the outset present in our soils. I am not aware whether your soils here are poor in lime, and therefore need to be supplied with it. But, gentlemen, the question is so important a one, not only for the cultivation of sugar-beets but for the production of farm crops generally, that it should be solved

#### Lime in Soil a Requisite.

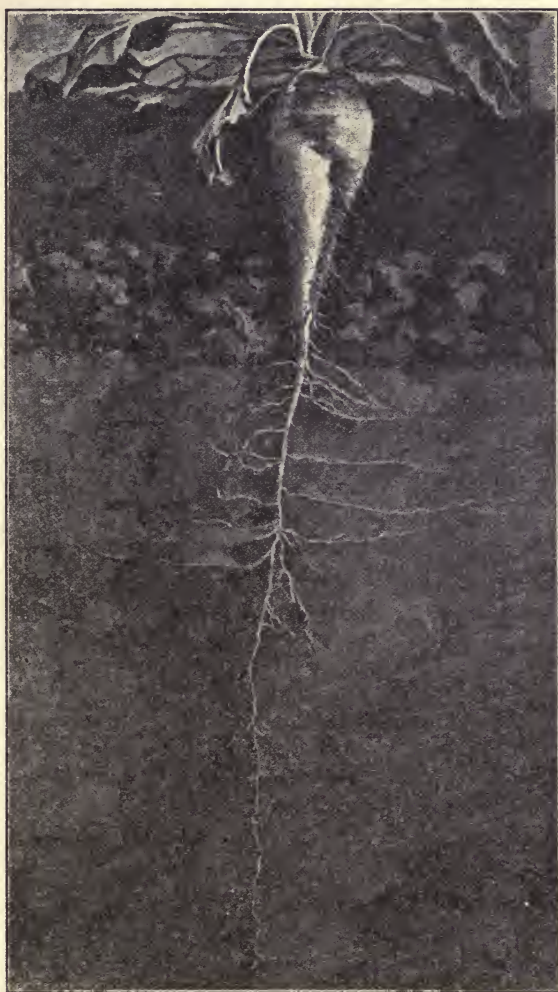
without delay. It is, as I have said, the most important of all agricultural questions. For beets not only need ample quantities of lime for their nourishment, for the direct satisfying of their lime requirements, but the indirect effects of the lime are more important still.

**Especially if Cold.** A soil which, when it is saturated with the moisture of winter, forms heavy clods, and is, therefore, in the spring, only capable of tillage late and with difficulty, loses at once this tendency to form clods if the necessary quantities of lime are applied to it. A soil naturally cold can be rendered warm, at least on the surface, if sufficient quantities of lime are added to it. A soil which has an adequate store of lime brings into activity all the constituents of the manures applied to it, not only those of dung, but also those of artificial manures, much more rapidly than soils in which such store of lime is not present. The plant foods introduced into the soil in manures are gradually, in the course of absorption by the soil, in great part converted into an insoluble form, and in that insoluble form they cannot at once be dissolved by the water of the rainfall. To render them soluble it is first necessary that carbonic acid should be developed in the soil, and that this carbonic acid should be dissolved by the moisture in the soil. Only then this soil moisture, containing carbonic acid, capable of quickly and readily dissolving phosphoric acid, potash and other food stuffs and of supplying them to the plants, thereby rendering possible the production of a heavy crop of beets rich in sugar.

**Deep Cultivation.** *The fifth requisite for growing the sugar-beet is deep cultivation.* Without a soil deeply loosened and exposed in winter to the atmosphere, beet cultivation cannot be successfully carried on. The beet requires a deeper tilth than other plants, because it can only with great difficulty overcome resistance in the soil. It goes very deep with its tap-root, and if it meets with strong resistance in the soil it does not form its tap-root, on which it is greatly dependent, in a sufficient manner, and the natural consequence is that the produce is small. Therefore, deep cultivation is an indispensable requisite for growing sugar-beet. But for carrying out this deep cultivation many things are necessary. We must have the requisite team power, the necessary ploughing apparatus



and the like; then, gentlemen, deep cultivation is not to be accomplished with the sub-soil plough alone; many other implements are necessary for working the deeply ploughed



Root System of Sugar-Beet, showing necessity of deep preparation  
of Soil.

Bulletin No. 13, California Experiment Station.

soil; the heavy roller, the grubber, etc., are requisite. Without them sugar-beets cannot be grown, and there can be no question that if you wish to carry on the cultivation

in an intensive manner a certain outlay is necessary, which, however, is rendered remunerative not only by the beet crop itself but also by the yields of other crops in the rotation. And it has to be borne in mind with regard to deep cultivation of the soil that by it we obtain not only heavier but also more certain crops. It is much easier to secure equality of yields, one year with another, in a deeply cultivated soil than in one the cultivation of which is shallow. In favorable circumstances you may obtain in a superficially loosened soil heavy yields of wheat, potatoes and other farm crops; but if unfavorable circumstances, of whatever nature, occur, the less deeply loosened soil fails, whether in a season that is too wet or in one that is too dry, whilst the deeply cultivated soil allows the injurious effects of excessive rainfall or the still more disastrous effects of drought to come far less into evidence. If therefore you go in for deep cultivation, for which ordinary agricultural appliances do not afford the means, you will find that under its influence your other crops also will give more favorable results.

More Liberal  
Use of  
Fertilizers.

*There are several other matters in this connection to which I shall revert in the course of my lecture; for example, the more liberal use of artificial manures, the selection of suitable varieties of the plants to be cultivated, etc.; but these are all secondary matters; the main thing is, and will be, deep cultivation; and this, as I have said, will be remunerative in the case of all other crops, as well as in the growth of the sugar-beet.*

Use of Drill  
and Hoe.

*A further, and, indeed, a fundamental condition for beet cultivation is that of connecting with it the use of the drill and the use of the hoe—and, indeed, the most active use of the hoe.* Gentlemen, if we have achieved something in the districts where beets have long been grown, we have done so not only by the use of the drill, but far more still by the use of the hoe, to which the cultivation of the beet, in the first instance for itself, but no less also for the other crops, gave occasion. If at the present season of the year you pass through our fields where sugar-beet cultivation is carried on, you see the long rows of laborers, who arrived towards the end of March, engaged in hoeing the wheat; and if it is still practicable, and the growth of the rye is not yet too far advanced,



it also is being hoed. If the necessary labor be available, then the barley, the peas, the oats, etc., should also be hoed, and those crops also, like the sugar-beet, will thrive under the use of the hoe, although hoe cultivation is not so indispensably requisite for them as for the latter. To attempt to carry on sugar-beet cultivation without the use of the hoe—whether the machine or the hand implement—is a perfect chimera. Without a thorough use of the hoe no heavy yields, and, still less, beets rich in sugar, can be obtained.

*The use of the hoe is a fundamental condition for the successful cultivation of the sugar-beet, because it is not only necessary for the extirpation of weeds—which is, of course, also a very important result of a thorough use of the hoe—but it is, above all, requisite for the complete and repeated breaking up of the hard crust which forms to an exceptional extent in the intensive cultivation of the beet, in consequence of the application of dressings of salts, such as Nitrate of Soda and potash salts, in order that air and warmth, the indispensable and vivifying elements of the soil, may be able to penetrate into it.*

#### Right Use of the Hoe.

The extirpation of weeds is, be it remarked by the way, also of the greatest importance in the growth of the sugar-beet, and moreover all the labor at the disposal of the sugar-beet farmer will likewise be profitably employed in the destruction of weeds in the wheat fields. It is extremely difficult for a farmer who can grow no very great breadth of crops requiring the use of the hoe to thoroughly keep down weeds. I do not know how it is with you here, whether weeds are common in your fields, whether wild mustard and other fine plants thrive here (laughter), but I expect from your climatic conditions that you are not very differently situated from what we were when as yet we did not carry on the intensive cultivation of the sugar-beet. To be frank, we must admit that we are not better than our neighbors, and that we have not by reason of our greater foresight brought our land into better condition than that of others elsewhere; the fact is, rather, that the means of doing so have been afforded us by the cultivation of the sugar-beet; and if you secure the same means by growing sugar-beet, you also, will, in a short time, enjoy the same freedom from weeds

#### Importance of Weeding.

on your land that we in the province of Saxony have now for the most part obtained, but which is at once lost again where intensive beet cultivation ceases to be carried on. In our district the common weeds are quite as widely distributed as in any other in Germany.

I now pass from this fundamental requisite of the cultivation of the sugar-beet, the active use of the hoe, to the next, and that is the application of the food-stuffs necessary for the sugar-beet.

Phosphoric  
Acid.

*The phosphoric acid requirements of the beets are not greater quantitatively than those of other farm crops; a heavy crop of it removes from the soil about 29 pounds, and an average crop from 19 to 22 pounds of phosphoric acid to the acre.* That is neither more nor less than a crop of rye, barley, oats or potatoes takes up, and the sugar-beet, from this point of view, really requires no heavier fertilizing with phosphoric acid than we are accustomed to give to our other farm crops. But, in the case of the sugar-beet, there is the circumstance that in its first young growth it undoubtedly requires a considerably larger provision of phosphoric acid than other farm crops. We can very easily convince ourselves of this if we heavily dress one-half of a field of beets or even a strip of one, with phosphoric acid and leave the other portion undressed. It will soon make itself evident that the early vegetation of the beets on the portion heavily fertilized with phosphoric acid progresses much more rapidly than on the part not dressed with phosphoric acid. From the outset, the beets grow far more quickly, they can be earlier singled, they shade the soil sooner and more completely, and every experienced grower of the sugar-beet knows that this is of the greatest importance. The earlier I am able to single the beets, the better and safer prospect I have for my crop. Every experienced grower of the sugar-beet knows that, with the exception of fields affected by threadworms and beet sickness, it is in its first youth almost exclusively that the sugar-beet has to fight against its enemies, and that the more rapidly it thrives the quicker it grows out of the reach of those enemies.

Therefore, gentlemen, we must employ an ample and not too restricted quantity of phosphoric acid for the promotion of this first period of growth. *And for the hasten-*

*ing and advancement of this early period of growth we require, not the form of phosphoric acid with difficulty soluble, such as we have it in basic slag or in the precipitated phosphates or even in bone meal, but exclusively the form which is soluble in water.* Nineteen pounds of phosphoric acid soluble in water are indispensably necessary to enable the beets to thrive, and in particular to secure a healthy and rapid first period of growth. Besides this, an additional quantity may be given in a less readily soluble form. Such a supply of phosphoric acid is an indispensable necessity, especially where the spring is cold and the soil at the time when the beets are singled is still but slightly warmed, as may well be the case under your climatic conditions.

But, gentlemen, on the other hand, the quantity of phosphoric acid to be supplied has also its limits. Formerly the sugar factories demanded quite excessive quantities of phosphoric acid, with the object of obtaining beets rich in sugar. They required fifty to ninety pounds and upward to the acre, and they believed that not only was this necessary in order to obtain heavy crops of beet, but also that the quantity of phosphoric acid stood in direct relation to the formation of sugar in the beet. This idea has been set aside by Hellriegel, who has proved that no connection exists between the phosphoric acid and the formation of sugar in the beet. On a soil poor in phosphoric acid you will indeed grow fewer beets than on one rich in phosphoric acid, for phosphoric acid is an indispensable food-stuff of the beet; but the crop of beet, although smaller in quantity, is relatively as rich in sugar as that of which the quantity is greater. Nor have I ever heard that a crop of beets which turned out to be a small one, and turned out to be a small one in consequence of a deficiency of phosphoric acid in the soil, was particularly poor in sugar. On the contrary, if we obtain a smaller crop, we usually get beets tolerably rich in sugar; and in the case of heavy yields there is a greater risk of a low percentage of sugar than in the case of smaller crops. Therefore, in the present state of agriculture, it is no longer thought necessary, as formerly was generally the case, to squander phosphoric acid in this manner; it is proper and customary to give to the beet no more than is required to render its first growth rapid and healthy, and

#### Use of Phosphoric Acid.



than is required for its later development and the perfecting of its structure, quite without reference to the formation of sugar, which, as we have said, is accomplished without the co-operation of phosphoric acid. For this, the nineteen pounds of phosphoric acid soluble in water, which we give to push on the crop, suffice, and if there is present in addition a store of some nineteen to twenty-two pounds, in a form not readily soluble, that is ample.

In numerous experiments in fertilizing which we have carried out in Saxony and the Altmärk, on soils poor in phosphoric acid, these quantities have always sufficed, and I do not doubt that they will also suffice under the conditions in which you are farming, regard being had, of course, to difference of climatic conditions. In colder situations, gentlemen, we are compelled to use phosphoric acid more, largely because there it is necessary to hasten the development of the beet more than in warmer situations; and I will therefore not apply the rules which we have just laid down to your district without reservation; but, for the reasons which I have given, I believe that you will have no need to have recourse to a more lavish use of phosphoric acid.

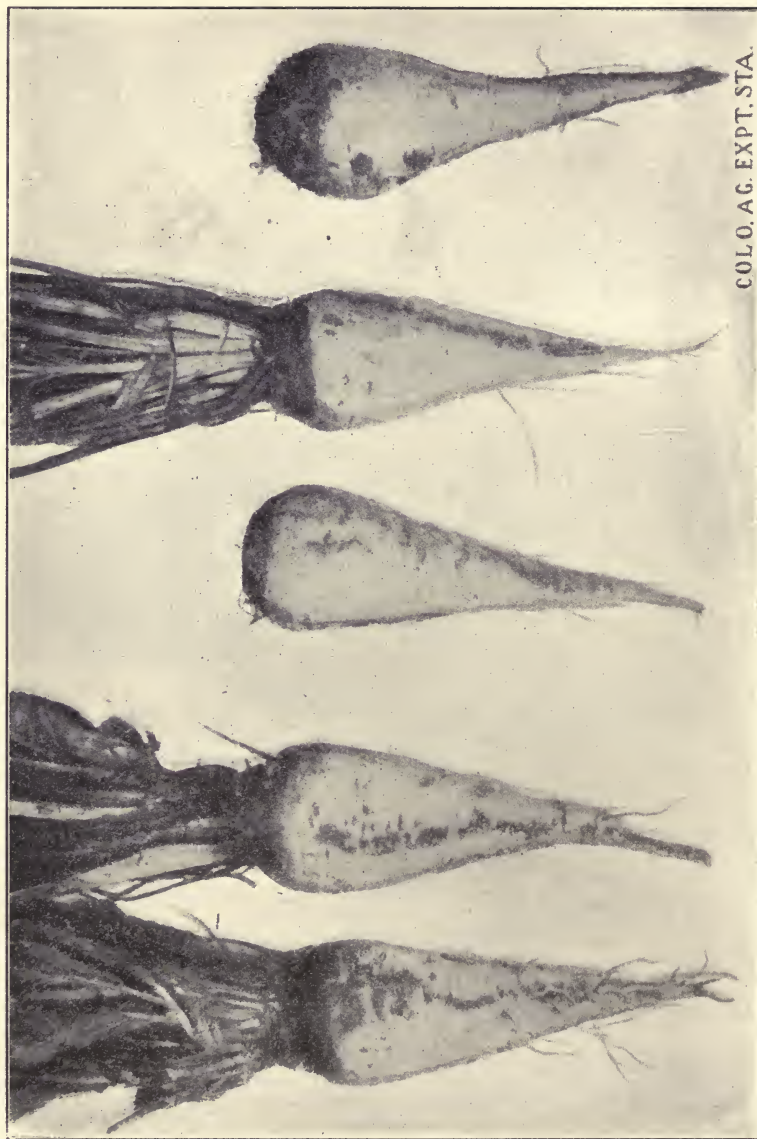
*Lastly, gentlemen, before I turn to the special topic with which I have to deal—the employment of Nitrate of Soda and other Nitrogenous manures—I have still to lay stress on one more point; the selection of the varieties of beet suited to particular conditions of cultivation.*

**How to Select Varieties.** In this matter, likewise, we do not now need to be anxious; for, gentlemen, in no department of agriculture has greater progress been made than in that of beet selection. The intensive and scientific manner in which beet selection has been carried on, has produced varieties, which are, so to speak, *en tout cas*, and which thrive just as well in France and America as in the Magdeburg district, in Austria-Hungary and South Russia, which bear all climatic conditions to which they may be exposed—the climate of districts bordering on the sea and the climate of the steppes—and which, notwithstanding the diversity of those climatic conditions, yield an equally high percentage of sugar. It was the Frenchman, Vilmorin, who gave the first direction to the selection of beets rich in sugar. But Vilmorin has long since been surpassed by the varieties of the brothers Dippe



Undesirable Types of Sugar-Beets.





Desirable Types of Sugar-Beets.  
(Topped beets indicate method of topping.)

and many others; varieties which all stand pretty nearly equally high. A slight superiority among the several varieties may still exist, but it has long ceased to be as great as it was ten years ago, so that really bad varieties of beet no longer come into the market and it is not necessary to be so anxious about the choice. The varieties have been so much improved by selection and scrutiny, that almost all are suitable for our climate; and therefore it is not necessary that we should exercise any extraordinary care in this respect.

Finally, I come to yet another question which is very important in its relation to beet cultivation, but which may readily be disposed of, and that question is: In carrying on an intensive cultivation of the sugar-beet, what am I to do with my farm-yard manure; am I to apply it all to the beets, or, if not, on which crops should it be used in carrying on an intensive cultivation of sugar-beets?

Gentlemen, for a long period we had great doubt about the direct application of farm-yard manure to sugar-beets, but those doubts have been removed by the experiments first of all made in Wanzleben by Counsellor Schäper, who may well be called the father of intensive and rational beet cultivation, and it has been demonstrated that there is scarcely a crop which shows itself so responsive to the application of farm-yard manure as the sugar-beet; always, indeed, subject to certain conditions. The application of farm-yard manure must not be overdone; we must not give fifteen or twenty tons of farm-yard manure, but eight to twelve tons are a dressing which is quite suitable for the beet. But here a proper selection must be made among the different kinds of dung which are at disposal, and sheep dung must be avoided; not because it would be in any way a poison to the beets, but because in sheep dung, which is collected in deep stalls, far more immediately assimilable combinations of Nitrogen are contained than in yard dung, the available combinations of Nitrogen of which are in great part lost in consequence of unfavorable circumstances. This, indeed, is one of the most important questions of the day in connection with agricultural economy. Sheep dung is so intensive in its action because all the important constituents, and in particular the urine, are present in it, whilst

Use of Farm-  
yard Manure.  
Kinds to Use.

the yard dung is less intensive in its effects because it has lost a great part of the active constituents, circumstances, which, of course, I cannot discuss here, but which represent the most important technical questions in connection with agriculture which is before us at the present day. Now, sheep dung is less suitable for beets, because it contains too many readily assimilable combinations of Nitrogen, and the only possibility of with certainty rendering beets poor in sugar lies in applying to them a manure which contains combinations too rich in Nitrogen. And this would happen if sheep dung were used.

**Good Effects of Application.** But as regards farm-yard manure in general. In the first place the effect of the application of farm-yard manure is to loosen the soil; the formation of carbonic acid, in connection with the formation of humus, brings about many useful changes; and lastly, in a dry year, the beets root much more easily in a field dressed with farm-yard manure. Therefore, both in its chemical and its mechanical effects, the application of farm-yard manure is of extreme advantage to the sugar-beet, always subject to the reservation already mentioned, and also to the further condition, which also tends to the interest of the grower himself, that the farm-yard manure has been deeply ploughed under in the previous autumn. To dress sugar-beets with farm-yard manure in the spring, may, in certain circumstances, be to poison them; for the period of drought which usually, at least with us, sets in soon after the tillage, and which frequently fills the heart of the farmer with anxious fears for the result of the harvest, causes the beets to suffer much during their early growth from deficiency of moisture. This danger would be greatly increased if the soil had been rendered too loose by farm-yard manure being ploughed under in the spring, nor would the peril to the development of the beets be obviated in a sufficient manner even by the use of the heavy roller.

*It is, therefore, wholly to the interest of the farmer to plough under the farm-yard manure in the autumn.* But, gentlemen, you who wish to grow beets, bear well in mind the fact that in colder situations the application of farm-yard manure is of still greater advantage than in warmer climatic conditions, and co-operate accordingly with the sugar factories, which freely allow you to employ farm-yard manure



within the limits laid down by me. How does the case stand in that respect here? (A voice: "It is freely allowed.") Well, gentlemen, then make free use of it.

*So much as regards the use of farm-yard manure; we now come to the application of the most suitable Nitrogenous fertilizer for the cultivation of the sugar-beet, that is to say, Nitrate of Soda.*

Gentlemen, it is, generally speaking, impossible to grow sugar-beets with profit without supplying them in a judicious manner with easily assimilable Nitrogenous food, and that, best of all, in the form of Nitrate of Soda. Of all our crops the beet is the one whose requirements in Nitrogen are the greatest; it is capable of taking up Nitrogen in far greater quantities than are usually supplied to it, and there are in this respect scarcely any limits to the increase of the yield—but with a certain reservation. For just as we have already learned that phosphoric acid hastens the growth of the young beets, so the reverse may in certain circumstances be brought about by an injudicious use of Nitrate of Soda; and therefore, Nitrate of Soda, valuable as it is in beet cultivation, must be used with judgment.

It should be the object of the beet grower to secure a ripe beet at the time of the harvest. But, by an excessive application of Nitrate of Soda the ripening is delayed, and an unripe beet is a beet poor in sugar; so that it is not to be doubted that an excessive use of Nitrate of Soda may go hand in hand with a diminution of the percentage of sugar, and therefore with a reduction of the value of the beets to the manufacturer. Gentlemen, I admit this perfectly, and nevertheless I entertain the firm conviction that in present circumstances, *sugar-beet growing cannot be carried on without an intensive use of Nitrate of Soda.* But in applying Nitrate of Soda the farmer must understand how to proceed in such a manner that the percentage of sugar in the beets does not thereby suffer loss; for the manufacturer is justly entitled to require the agriculturist to deliver to him at the factory a beet as rich in sugar as is capable of being produced under the ordinary conditions of the district.

Nitrate the  
Most Suitable  
of the Ammo-  
niates for  
Sugar-Beets.

Beets Need  
Ammoniates  
More Than  
Phosphates  
or Potash.

For Sugar-  
Beets Must be  
Ripe.

But, with the same justice, the farmer, on his part, may claim that no restrictions be imposed upon him on the part of the factory which would prevent him from obtaining the heaviest possible yield of beets on a given area. But both are to be reconciled, as I now propose to point out to you, by a proper use of Nitrate of Soda.

Ammoniates  
All Converted  
into Nitrates.

*The various forms of Nitrogen, as sulfate of ammonia, dried blood and tankage, are in the long run converted into Nitrates in the soil. There are present in the soil ferments, bacilli (which indeed carry on their work in every division of life), which, in the end, convert substances containing organic Nitrogen and ammonia into Nitrates. But, gentlemen, in the conversion of these substances into Nitrate, a certain loss takes place. In the conversion of ammonia into Nitrate, gaseous Nitrogen is developed, and this gaseous Nitrogen is altogether valueless, for the atmosphere already contains 79 to 80 per cent of it. But the Nitrogen-consuming*

Large Losses  
of Ammonia  
when Ordinary  
Ammoniates  
Are Used.

*plants—beets, potatoes, wheat—are unable to take up this atmospheric Nitrogen; and an ammoniacal manure, even if the ammonia is in the course of time converted into Nitrate, can only have effect in proportion as Nitrate is produced from the ammoniacal Nitrogen. We know that 100 parts of ammoniacal Nitrogen yield only about 85 parts of Nitrate Nitrogen, so that the effect of the same quantity of ammoniacal Nitrogen to Nitrogen in the form of Nitrate of Soda is in the proportion of 85 to 100.*

*In the case of dried blood and tankage the comparison is still more unfavorable. Substances containing organic Nitrogen which are intended for plant-food must decay in the soil and first become ammonia, which has subsequently to be converted into Nitrate. In this process of decomposition and of conversion into ammonia, losses of Nitrogen take place, and to these losses have to be added those incidental to the conversion of the ammonia into Nitrate, and we have thus two sources of loss, in addition to which it has to be taken into account that, in the case of manures containing organic Nitrogen, only 65 per cent of the effect of the like quantity of Nitrate Nitrogen is apparent*



in the end. *Therefore we come to the conclusion that the Nitrogen of Nitrate of Soda is in all respects the most effective, and, at corresponding prices, the form of Nitrogen generally to be recommended.*

If sulfate of ammonia is so cheap that, for equal quantities of Nitrogen, it costs only 85 per cent of the price of Nitrate of Soda, it has then to be considered whether

How Other  
Ammoniates  
Act.

we cannot give part of the Nitrogen in the form of the ammoniacal manure. But up to the present the prices of the manures containing ammoniacal Nitrogen have been too high for us to be able to think of employing them. Agriculturists have indeed made much and frequent use of ammoniacal manure, but, in my opinion, quite injudiciously.

For, gentlemen, the conversion of ammonia into Nitrate is not completed in the soil all at once, but is brought about by the growth and nourishment of small organisms, and this process requires a certain time; I cannot say how long it occupies, but some lapse of time always takes place before the last of the ammonia in the soil is converted into Nitrate. *But as the beet is quite unable to consume ammonia, and can only live on Nitrate, it is, in my opinion, an agricultural sin of omission not to place at its disposal at the outset the quantity of Nitrogen necessary for its first development in the form of Nitrate of Soda.*

For this first development, which, I repeat once more, must, in the case of the sugar-beet proceed rapidly and healthily, I hold the application of Nitrate of Soda in certain quantities to be quite indispensable; *so that it may with truth be said that without Nitrate of Soda the profitable cultivation of the sugar-beet cannot at the present time be carried on at all.*

Nitrate  
Indispensable.

A portion of the Nitrogen may, if sulfate of ammonia be worth its price,—*which at present it is not*—be given in that form, but there can be no question of any preference to be given to the application of the ammoniacal fertilizer; it may in the most favorable circumstances replace a portion of the Nitrate of Soda.

It is indeed possible by the cultivation of catch crops and the maintenance of a greater head of cattle, and likewise by the preservation of the Nitrogen of the dung, to introduce so much heart into the soil that, at the outset,

sufficient Nitrogen is at the disposal of the plants; but from what I know of most kinds of soil in Germany, they are thoroughly hungry for Nitrogen, and I believe that hunger for Nitrogen exists also in your soils. Or have any of you to complain of a superfluity? (Laughter. A voice: "Not outside the yard of the posting house!") Yes, possibly so, but that is only a quite exceptional case, which we may leave out of sight, so the remarks which I have made will be perfectly applicable to your circumstances and in those circumstances *you cannot think of carrying on the cultivation of the sugar-beet profitably without an intensive employment of Nitrate of Soda.*

## Formula for Sugar-Beets—Per Acre.

Nitrate of  
Soda for  
Sugar-Beets

300 pounds fine ground bone meal.

100 pounds fine ground bone.

100 pounds sulphate of potash.

300 pounds Nitrate of Soda.

The Nitrate of Soda may be divided into two equal portions before mixing, and 150 pounds only put in the mixture, and the other 150 pounds reserved for use as a top-dressing.

For sugar-beets when soil is light, apply 160 pounds of Nitrate at the time of planting, and later, 140 pounds at the time of the first hoeing.

With heavy clay soils, 300 pounds may be put on at time of planting, and this followed later by thorough hoeing.

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## Sugar-Beets.

Quantity of Nitrate of Soda to be applied to the acre.	Character of soil.	Time of fertilization.	REMARKS.
150 lbs.	Upon light soils.	At the time of planting.	The application of Nitrate of Soda increases the yield of sugar-beets very largely, and by proper use produces sugar-beets very rich in sugar. In the use of large quantities of Nitrate one obtains beets rich in sugar when choice varieties of sugar-beets are cultivated, and when it is applied early and is quickly appropriated by the beets, in order that the ripening process may not be prolonged. The delaying of the ripening process is prevented when bountiful supplies of available phosphoric acid are present in the soil. Every 224 lbs. of Nitrate of Soda is able, according to Wagner, to produce an increased yield of 14,080 lbs. of sugar-beets rich in sugar and a corresponding increase in tops or leaves.
And still further 150 lbs.		At the time of the first hoeing of the beets.	
Or 300 lbs. at one time.	In the case of heavy clay soils, a large application of Nitrate may promote the formation of a crust, which must be prevented by careful hoeing. The richer the soil and the more freely it is fertilized, the closer the sugar-beets must be planted.	At the time of planting.	

## SUMMARY.

# Sugar-Beets for Profit.

Abstract of Dr. Maercker's foregoing Lecture.

Almost all Kinds of Soils Suitable for Sugar-Beets. The somewhat popular idea that certain types of soils are necessary for Profitable Sugar-Beet culture seems to have no foundation in fact. Almost any type of soil is suitable for sugar-beets, so long as moisture and tillage, and the necessary plant food are supplied. Even heavy clay soils, by systematic liming, may return regularly very satisfactory sugar-beet crops. Sugar-beets require a warm soil and sub-soil; that is a soil free of stagnant water both above and below the surface. In practice this means a soil well drained, if not naturally, then artificially. Drainage alone, Good Drainage a Necessity. is not sufficient, however, if the conditions are such that the soil is apt to become cloddy; on these soils *lime* must be used freely, broadcasted in the early spring. With the soil mellowed by *lime* and proper *drainage*, we come to the next essential in the profitable culture of sugar-beets—*deep cultivation*. If soils are at all heavy, they should be fall plowed, and even cross plowed, the roughly turned soil left to the action of the winter weather. The crop requires a deeper tilth than other crops, as it seems to have little power of soil burrowing on its own account, especially in soils at all compact naturally; yet, a well-proportioned tap root seems to be one of the conditions of a high sugar content. Not only must the soil be deeply worked in its preparation for planting, but it must have continuous and thorough cultivation during the growing season. The earth mulch must be maintained, and the soil kept free of weeds and surface

Warm Soil Best.

Use of Lime.

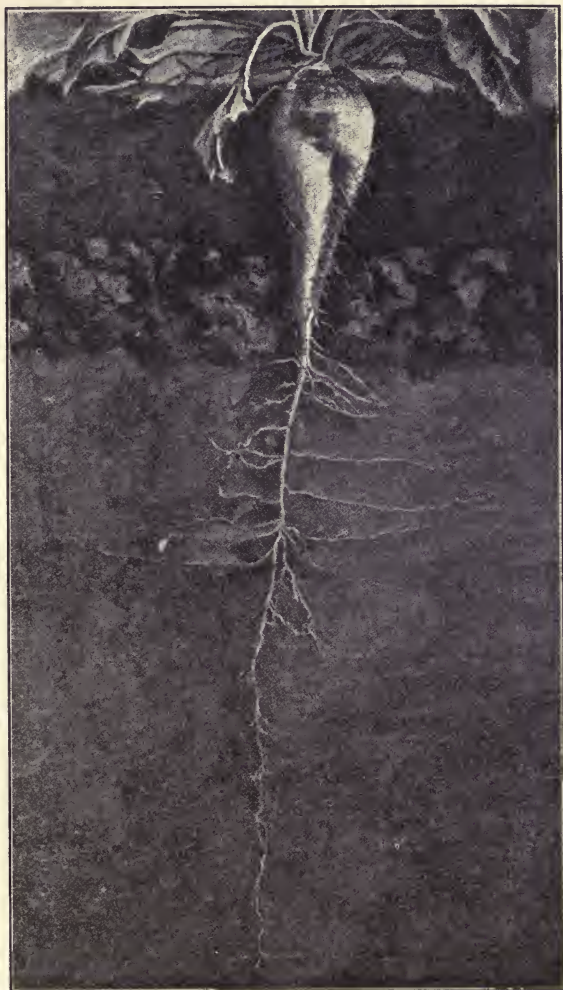
Deep Cultivation and Thorough Weeding Indispensable.



crusts; these crusts are a result of using very high grade plant foods, but intensive cultivation demands their use.

Nitrate of Soda for Sugar-Beets

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Showing root system of Sugar-Beets and great extent of feeding.  
Bulletin No. 176, California Experiment Station, 1906.

The plant-food of sugar-beets is, of course, the same as for other crops, ammoniates, phosphoric acid and potash. The phosphoric acid must be used in ample quantities in order to push forward a well nourished early growth, and with this

Acid  
Phosphate.

crop water-soluble phosphoric acid should be used, the form found in acid phosphate. There is no direct connection between sugar formation and phosphoric acid plant food, but phosphates unquestionably prepare the way for the development of sugar by influences to come later in the growing season. Abundant phosphoric acid in the earlier stages of growth puts the crop through to an early ripening, and the earlier sugar-beets are matured the more time they have for sugar making. Ammoniate plant food best for the sugar-beet is a matter of some discussion, but the roughage ammoniates of the farm, such as farm-yard manure, etc., are used extensively, and with proper care are effective, except perhaps in the case of sheep manure, which is too rich in



Row Irrigation of Sugar-Beets.  
Bulletin No. 176, California Experiment Station, 1906.

available ammoniates to be used to advantage, as losses are unavoidable for a fall application. The best practice seems to be to broadcast the manure and plow down in the fall—it is never wise to top-dress sugar-beets with manure of the roughage type in the spring. The best form of plant food ammoniate is the Nitrated ammonia of Nitrate of Soda. Sugar-beets take all their ammoniate plant food in the form of a Nitrated

ammonia; while all ammoniates are in time converted into the Nitrated form in the soil, the action is always irregular and is accompanied by a heavy loss of ammonia. With Nitrate of Soda all these disadvantages disappear. It is estimated that sulphate of ammonia loses fifteen per cent of its ammonia in this process of transformation, and that packing-house ammoniates lose thirty-five per cent, farm-yard manures lose from forty to eighty per cent. For all this great loss, the disadvantage is probably not so much the actual loss of ammonia as

Great Losses  
from Use of  
Ordinary  
Ammoniates.

the irregularity with which the plant food ammonia is supplied the crop. If the Nitrated plant food is not present when wanted, the crop must wait for it, and nature in agriculture waits with very bad grace. Perhaps the best application of Nitrate of Soda on farms carrying the stock usually necessary to do the work of the farm and supplement natural losses, and the resulting manure regularly fall-plowed down, is 300 pounds per acre. It is claimed to be proved that for an average year, 100 pounds of Nitrate of Soda will produce an increased crop of sugar-beets of 2,500 to 3,000 pounds per acre. Experiments conducted by Professor Maercker gave an increased yield of from 4,000 to 4,800 pounds for an application of 150 pounds of Nitrate of Soda per acre, a second application of the same amount also resulting in an increased yield of 4,000 to 4,800 pounds per acre, but a third application of the same amount gave an increased yield of but 1,600 to 2,000 pounds; hence, the utility and profitableness of Nitrate of Soda applications on soils of fairly good condition, commence to be subject to question only after an acre application of 300 pounds has been reached.

This Nitrate of Soda is not all applied at one time; in fact, from 150 to 200 pounds are all that should be applied at one time. Nitrate of Soda spreads rapidly

Time and  
Method of  
Application.

throughout the soil and this is one of its great advantages in quickly bringing plant food to the growing plants, but the same principle may prove a disadvantage in case of a too lavish use, as more or less of the Nitrate of Soda is lost through simple seepage. Fall applications are not advisable for this same reason. The best way to apply 300



pounds per acre is to broadcast 150 pounds when the soil is being prepared for seeding in the spring, and the remaining 150 pounds from six to eight weeks later; the second application as a top-dressing, well worked into the soil. After top-dressing, the surface tillage should be deepened, and the treatment made more thorough; where high-grade plant food materials are used as a top-dressing, there is always a tendency to form surface crusts, the remedy is simply a trifle more thorough cultivation and a little deeper.

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## Work of Colorado Agricultural Experiment Station.

Abstract of Bulletin No. 115.

### Fertilizer Experiments with Sugar-Beets.

By A. H. Danielson.

Colorado Station.

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These experiments extended over three years and were made to test the effect of different artificial fertilizers and manure on the yield and quality of sugar-beets under practical field conditions.

The experiments consisted of a series of plots with fertilizer containing the three essential elements, Nitrogen, phosphoric acid and potash, alone and in all possible combinations. After preliminary experimenting the source of the elements chosen as being more easily soluble in the soil, was for Nitrogen, Nitrate of Soda; for phosphoric acid, acid or soluble phosphate rock and bone, and for potash, high-grade sulphate of potash.

Other fertilizers used were also raw bone meal, ground oyster shell, basic slag and dried blood.

The size of the plots ranged from one-tenth to six-tenths of an acre each, the yields were from 10 tons to 25.5 tons, and the profit from the most effective element, from \$6.00 to \$15.00 per acre over the cost of application.

Colorado soils are chemically exceptionally rich in phosphoric acid and potash, with an excess of lime, only Nitrogen and humus are likely to be somewhat low.



Colorado soils and climate have proven under irrigation to be capable of producing a very satisfactory yield of high quality sugar-beets under normal conditions. However, the need is being felt for some fertilizer to increase the yield where farm manure is becoming scarce or not available.

The most essential of the results as obtained each year are briefly given :

### 1903.

Cow manure alone at the rate of from 15 up to 60 tons per acre, and Nitrate of Soda alone at the rate of 150 pounds per acre, had about the same effect, each increasing the yield about four tons per acre.

The results from the potash and phosphatic fertilizers were largely negative, and Nitrogenous fertilizers, when used together with the preceding, were also ineffectual in increasing the yield.

The quality of the beets was good, but poorest with the larger quantity of manure ; the average sugar 14.6 per cent, purity 84.4.

### 1904.

The fertilizer containing Nitrate of Soda gave the highest yields, except where used in "complete" fertilizer with potash and phosphoric acid.

Nitrate of Soda at the rate of 175 pounds per acre seemed to be the best amount to use on this soil, increasing the profit about \$9.00 to \$10.00 per acre over the cost of application.

There appeared to be no difference between the results from applying the entire amount of Nitrate of Soda at the time of seeding, and in several applications throughout the season.

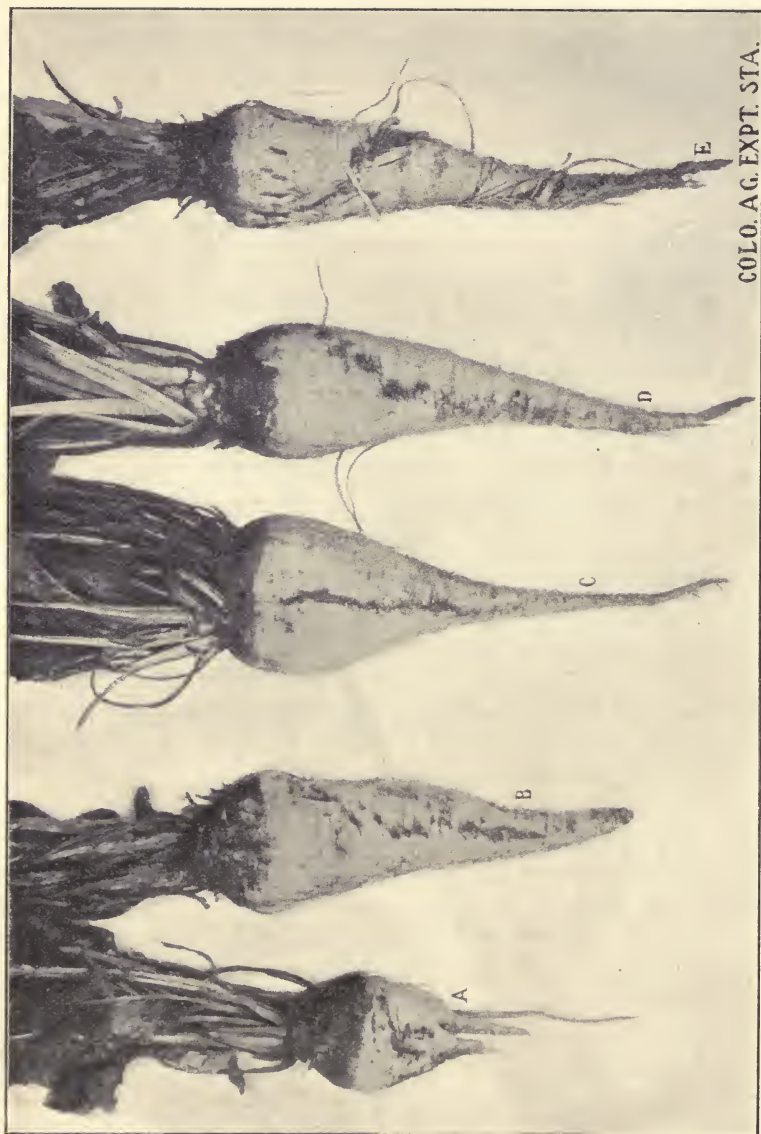
Potash seemed to increase the yield somewhat this season, but only just about paid for its application.

Refuse lime cake from the sugar factories was ineffective.

The quality of all the beets was good, the average being, sugar, 15.4 per cent, purity, 87.8.

### 1905.

This season those plots with Nitrogen in the form of Nitrate of Soda gave the highest yields.



Varying Types of Sugar-Beets.

A—Burned off by stable manure unevenly distributed in row. B—Spiral constrictions on beet. C—Rapidly tapering beet—a loss in tonnage. D—Irrregular spiral depressions on beets. E—Irrregular growth of fibrous roots.

The same tendency is shown as in the previous years, of the apparent neutralization of the effects of Nitrate when used together with potash and phosphoric acid in "complete" fertilizer.

There was no additional net profits from using over 200 pounds of Nitrate of Soda per acre. This quantity was able to increase the net profit \$6.00 to \$7.00 per acre over the cost of fertilizer.

The shape and size of the beets were excellent, average sugar 14.9 per cent, purity 86.5.

### Residual Effects of Manures and Fertilizers.

The increased yield from cow manure about covered the cost of the manure and its application the first season. The second year the larger yield of the manured plots over those not manured was about the same, therefore clear profit. The third year the effects of the manure entirely disappeared.

As good yields were obtained with medium amounts of manure as from large to excessive quantities.

In the case of the artificial fertilizers there appeared to be little after-effects, except there appeared to be decided residual effects from Nitrate of Soda in the year after its application.

### The Beet and the Leaf or Top.

There was found to be no definite relation between the size of the beet and the percentage of tops, to sugar contents and purity. That is, on the average, the quality of the beets does not seem to be influenced much by its size or amount of tops.

The average weight of fresh, green tops was found to be 44 per cent of the weight of the beet. Estimating that the tops will air-dry to one-eighth the original weight, a 15-ton crop of beets will produce eight-tenths (0.8) ton dry tops per acre. The present current price of beet tops for pasture is from \$2.00 to \$3.00 or more per acre.

### Maturing of Beets.

From samples taken during several years, from beginning to end of harvest period, it is shown that there



Nitrate of Soda for Sugar-Beets is comparatively slight increase in sugar contents and purity, or yield, after the last week in September.

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### Practical Suggestions.

#### The Kind of Fertilizer to Use on Sugar-Beets.

Nitrogenous fertilizers are the only ones which have proven to have any decided effect in increasing the yield of beets. Nitrate of Soda, being easily soluble, has proved most satisfactory.

#### The Soil.

The most profitable use of this material will probably be on soils which are not in condition to produce close to the maximum tonnage of the district.



Topping and Weighing Samples of Beets in Fertilizer Experiment Tests to Determine Per cent Tops.—Colorado Experiment Station.

The best results would be obtained by using Nitrate of Soda along with a light coating of manure, to supply the necessary humus.

#### The Beet.

No injurious effects have been noticed from the use of moderate amounts of Nitrate of Soda or manure upon



the quality of the beet. A strong, thrifty green growth is secured from the time plants are up, the difference being marked throughout the whole season.

Excessive quantities of either Nitrate or manure would tend to lower the sugar content and purity. No bad effects from the use of Nitrate upon the tilth of the soil has been noticed.

#### How Used.

The most rational amounts of Nitrate of Soda which can be used on Colorado soils is probably from 150 to 300 pounds per acre. The larger quantities can better be used on poorer soil. After screening it can be applied by broadcasting with hand or machine and harrowed in before seeding.

Drills for distribution can also be used, or by attachment to the seed drill applied with the seed at time of seeding. When so used it favors strong germination of the seed, as all soluble fertilizers used have been found to do.

The expense of application by broadcasting will be about 15 cents per acre.

(Signed) A. H. DANIELSON.

1907.

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### The Use of

### Nitrate of Soda on Sugar-Beets in Colorado.

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In the few years that the sugar-beet industry has been established in Colorado, we have found that our conditions of soil and climate are such that we can grow better beets and more of them than any other State in the Union. For instance, several districts of several thousand acres have been able to report averages of 15 tons and more, per acre, with sugar at 16 to 18 per cent. This is more than remarkable when it is considered that the averages include many areas that made only one to two tons per acre, this poor product being the fault of the farmer more than the land. The industry has also been one of the strong factors which have caused the greatly increased value of good farm

lands in Colorado and the cutting up of the land into smaller tracts. And no wonder! The writer knows of several instances where the price of the land at more than \$100 per acre has been cleared in one season.

To give these kinds of returns the land must be in good condition from previous growing of alfalfa on the land or using good manures. The best yields are obtained by a combination of both. When the land plays out by too long growing of sugar-beets we can, of course, bring it back in shape again by alfalfa in a few years. But the trouble is that it takes two or three years for alfalfa to become well established, and when once established it hardly pays to plow it up right away. It is very desirable, then, that the land be kept in good condition for the production of paying crops of sugar-beets as long as possible. This is made more necessary by the fact also that many farmers have gone into debt for the land and want to pay out as quickly as possible. And to do this there is no surer crop than the sugar-beet if the yield can be kept up. Alfalfa, of course, will make the land as good as ever again, but it will take several years to do that. Good manures have also proved to have wonderful effects in increasing the yield of our soils. But this fact has also been discovered by others, so that often it is impossible to get, unless the farmer is in shape to feed cattle or sheep on his own farm, and this often is not possible. Even those that are able to secure a quantity of manure, often can not get enough to cover all the land they would like to put in beets. Thus the farmer is often "up against it" and would use commercial fertilizers if he were sure what kind would do any good.

### What Elements a Soil Needs to Grow Crops.

Long ago science found out that only three or four elements in the soil were used to such an extent by crops that it would ever be necessary to replace them to keep the soil from running out. Those elements are Nitrogen, Potash, Phosphoric Acid and Lime. Sometimes one or more of these things are naturally absent in the soil, or may be in such shape that plants cannot easily use it or get it. When such is the case, crops are increased by adding

the lacking element in fertilizers; and the best results are obtained if this element in the fertilizer is in such chemical combination that the plants can easily use it.

## Colorado Soils.

Chemical analysis has shown that our soils contain more than enough of most elements to grow good crops. Lime is present in such large quantities that there would be some to give away. The only things which are apt to be short in our soils are Nitrogen and humus. Humus is the decayed parts of animals or plants and when there is enough of it in the soil we say it is mellow, which means, usually, rich. Both Nitrogen and humus in our dry climate are used up pretty fast. Both can be replaced by growing such plants as alfalfa, peas, vetches or beans or by manure. For it is the large amount of Nitrogen in manures which makes it chiefly valuable, but without these it takes years to grow alfalfa and similar crops.

## What is Best for Sugar-Beets?

The chemist can tell us, of course, what is in our soils, and whether there is enough of everything, but he cannot so easily tell us whether it is in such shape that the plants can make the best use of it. And, moreover, different plants use more of one element than another. When it comes to finding out which are the right elements to use on sugar-beets for best results, or in what form such elements should be, about as good way as any is to mix them with the soil where beets are to be grown, using the different materials alone and in all possible mixtures, on different patches of land, and do this for several years to make sure.

The writer has been in a position to make numerous experiments on the effect of the several necessary elements on sugar-beets from different sources for several years, and has been asked to give briefly the results and the best way to use such fertilizers.

In these experiments it was found that neither potash or phosphoric acid alone or together had any decided effect upon the sugar-beets in increasing the yield. Not enough even to pay for themselves. Nitrogen, however, from Nitrate



of Soda or manures gave a decided profit over the cost of application. It was also found that the potash and phosphoric acid from the commercial fertilizers had a strong tendency to neutralize the effect of Nitrate of Soda upon the yield, when all were used together. Nitrate of Soda was chosen as the source of Nitrogen, because the Nitrogen in it is the form that it is easily and quickly used by plants and it is also the most easily soluble of all and most completely available of all forms, so that it diffuses throughout the soil within easy reach of the roots of plants. This quality is especially valuable with a plant like the sugar-beet, which is rather weak while a young plant. It is in the early part of the season that energizing of growth, if needed, is likely to be the most effective, for it is at this time that the tonnage is made in the case of the sugar-beet.

## Where and How to Use Nitrate of Soda.

As it takes from eight to twelve tons of sugar-beets per acre to pay the expenses of growing them, no land is likely to be planted to beets which will give less than ten tons, and twenty tons is a pretty good yield.

As nearly everyone can get a little manure, and our soils need humus anyhow, the best plan is generally to use Nitrate with a light coating of manure. In this way the maximum effect of both would be obtained. But it must be understood that no fertilizers will take the place of poor preparation of the soil or poor care of the crop. The land must be in good physical condition to make the best use of the plant food already in it or to be added to it.

## Will Nitrate Injure the Quality of the Beet or the Soil?

Excessive quantities of either manures or Nitrate of Soda are not recommended. This would not be profitable anyhow, because the large quantities of either would not pay for themselves in the increased yield. We have also the advantage of irrigation, by the proper use of which the quality of the beet can be influenced.



As to the effect of the Nitrate of Soda upon the soil, it might be argued that the Nitrate in producing a large yield would use up so much of the other ready plant foods that there would be none left for the next crop. Contrary effect, however, has resulted in actual practice. In our soils we have ample quantities of the other two necessary elements by potash and phosphoric acid and these are held in reserve and are constantly being made available or set free for the use of plants through the chemical action in the soil, which is always going on.



Topping Beets.—Colorado Experiment Station.

It has been claimed by inexperienced critics also that Nitrate of Soda has a tendency to make the soil more compact or less easily workable. In practice it is difficult to see how this could take place with the many hoeings and cultivations the beet crop is bound to receive, and, in fact, it does not take place. But if both causes as to injurious effect should be partly true it would be set aright by the rotations with grains, alfalfa or other crops, which is finally inevitable for the best all-around results in crop production.

## How Much Nitrate is Best to Use.

The amount of Nitrate which is most profitable to use depends upon the condition of the soil, and, of course, upon the pocketbook. A reasonable quantity will be from 150 pounds to 300 pounds per acre. More can be used to advantage upon naturally poorer land than upon the more productive. There is a limit to the most profitable amount to use, depending upon the condition of the land itself. A soil will not produce over a certain limit for that particular season, no matter how much plant food is present. As much as 580 pounds has been used on rather poor land with a little profit, but not a profit in proportion to the results from the use of 300 pounds.

## When and How to Use Nitrate— Cost of Application.

While there has been found to be little difference in results between applying all the intended quantity at once before or at the time of seeding and the same quantity used partly at the time of application and the balance in a couple of dressings later at different periods during the growing season, it will probably be best, until this matter is better understood, to apply the Nitrate in two portions, half the quantity at or before the time of seeding and the balance broadcasted over the beets after they are well established, before the first hoeing and thinning.

No matter in what manner the Nitrate may be applied, the lumps must be broken up and all passed through a  $\frac{1}{4}$ -inch or  $\frac{1}{3}$ -inch sieve or screen. The Nitrate can then be broadcasted just before the last harrowing before seeding. This can be done by the use of an endgate seed or fertilizer sower, by which two men with a team and wagon can cover 40 to 50 acres per day. At 40 acres a day and \$6.00 for man and team, this will be at an expense of 15 cents per acre. The labor of screening and resacking should not exceed 5 cents per hundred pounds. The broadcasting can also be done by means of a fertilizer distributor made for the purpose, something after the manner of a grain drill. By the use of this sower, one man and team could probably

cover half the above number of acres. There are objections to the endgate sower, as it is quite difficult to sow the fertilizer evenly in a wind.

Nitrate of  
Soda for  
Sugar-Beets

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The Nitrate can also be sown at the same time as the seed, and in the same row, by the use of a fertilizer attachment to an ordinary drill. Beet drills are also manufactured especially for this purpose with two hoppers or boxes to contain seed and fertilizer. The fertilizer falls after the seed from a separate spout or tube in such a way



Weighing Samples in Nitrate Experiments.—Colorado Experiment Station.

that the seed is covered by a layer of soil and the fertilizer comes on top of this layer when all is covered by the soil.

It might be supposed that a strong, soluble chemical sown with the seed in this way would injure the seed, but, on the contrary, it has been found that this *favours strong* germination of the seed. The Nitrate is so soluble that in contact with the moist soil, it disappears into the soil in a few days, before the beet seed is ready to sprout.



## What Returns to Expect.

Anyone who is contemplating using fertilizers on sugar-beets is naturally anxious to know what to expect in probable returns. It may be stated that in Official experimental work covering three years, and also in practice, the returns due to Nitrate of Soda in quantities mostly of 200 pounds per acre and less, have given returns in value of beets over the total cost of the Nitrate applied only, estimated at \$3.00 per 100 pounds, ranging from about \$7.00 to \$15.00 per acre. It may also be stated that the use of Nitrate of Soda on sugar-beets in Colorado has passed the experimental stage, one factory district alone having used several hundred tons during the last two or three years with profit.

The best time and method of application of Nitrate of Soda to sugar-beets under Colorado conditions, the result of my experiments shows that *all* the Nitrate can be applied at the time of planting the seed, or immediately before, and harrowed into the soil.

The Nitrate of Soda should all be passed through a screen of  $\frac{1}{4}$ - or  $\frac{1}{3}$ -inch mesh before application, and can be broadcasted through "endgate" seeders or applied with ordinary grain seed drills fitted with agitators of some sort. I sowed the Nitrate with an ordinary grain drill fitted with a revolving rod, carrying cross-pieces over each feed "hole," and seeded the beet seed immediately afterward.

Nitrate of Soda, or any other fertilizer, can also be applied by an attachment to the ordinary sugar-beet seed drill, although in the case of Nitrate of Soda, this is not recommended, because these attachments are not yet fitted with agitators to prevent the Nitrate from "bridging." Every sugar-beet grower understands what the meaning of this is.

A. H. DANIELSON.



Supplement I.  
Michigan Agricultural Experiment Station,

Bulletin 179.

Sugar-Beet Investigations.

By J. D. Towar.

Abstract.

Nitrate of  
Soda for  
Sugar-Beets

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Coarse manure applied some two months before sowing the beets resulted in some increased yield and beets of a normal percentage of sugar. What the Michigan Authorities Say.

Carefully prepared home mixed fertilizer gave higher yields and better beets than stable manure.

Nitrate of Soda in combination with other elements generally increased the yield with a normal per cent of sugar.

*But in every case Nitrate of Soda gave higher yields than sulfate of ammonia.*

Wood ashes and salt increased the yield of beets only slightly.

One ton of air-slaked lime per acre increased slightly the yield of beets on the uplands without affecting the percentage of sugar.

On muck land one ton of air-slaked lime per acre in combination with other fertilizers decreased the tonnage eleven per cent, and reduced the sugar content from 9.64 to 7.68 per cent. When lime was applied alone on muck land, increased applications increased the tonnage of beets, but decreased the percentage of sugar.

Early planting gave larger yields and slightly higher percentage of sugar.

Clay loam soil produced the largest tonnage and the highest percentage of sugar, followed by other soils in the order below, except that the tonnage on muck is next to clay loam; sandy loam, sand clay, muck.

Throughout the period of growth there was a slightly greater development of leaf on the plots receiving lime than on those under similar treatment, though unlimed; while **to the credit of Nitrate of Soda** *was earlier germination and a decidedly greater development of the plants all through the first half of the season.*

Attention is called in the following table to the effect of Nitrate of Soda as compared with sulfate of ammonia, as a fertilizer for sugar-beets.

	In complete fertilizer, Plots 5 and 7.		In complete fertilizer, with lime, Plots 6 and 8.		Alone. Plots 11 and 12.	
	Yield pounds.	Per cent. sugar.	Yield pounds.	Per cent. sugar.	Yield pounds.	Per cent. sugar.
Nitrate of Soda . . . . .	15,630	15.25	17,750	15.48	13,680	15.34
Sulfate of Ammonia . . .	15,000	15.10	14,630	15.78	13,620	13.98
Gain in favor of Nitrate of Soda . . . . .	630	—.15	3,120	—.30	60	1.36

*The yield in every case was in favor of Nitrate of Soda, while the varying per cents of sugar leave that feature of the question still very inconclusive.*

Comparing plots nine and ten in table one, page 95, we find that Nitrate of Soda produced 4,200 more pounds of beets per acre, which were 1.76 per cent richer in sugar, with a material increase in the co-efficient of purity.

In connection with the College Farm soil test experiment a comparison of ammonia and Nitrate Nitrogen was made. The soil was medium loam and of uniform character, dissolved phosphate rock and muriate of potash applied in like quantities in each case.

	Yield, pounds per acre.	Per cent. sugar.	Purity.
Complete Fertilizer, containing Nitrate Nitrogen . .	11,471	15.22	81.9
Complete Fertilizer, containing Ammonia Nitrogen	9,688	12.69	67.0
In favor of Nitrate Nitrogen . . . . .	1,783	2.53	14.6

## Michigan Experiments on Sugar-Beets in 1901.

(Extract from Michigan Bulletin 197,  
Issued 1902.)

A field was planned to test the effect of excessive amounts of each of the various fertilizing elements in comparison with normal applications in the form of commercial and home mixed fertilizers.

A standard brand of commercial fertilizers was selected and a mixture equal in fertilizing value to 250 pounds was prepared. *This required 32 pounds of Nitrate of Soda, 25 pounds muriate of potash, and 137 pounds of dissolved phosphate rock.* The six plots of the experiment received applications as follows :

Plot 1.—Nothing.

Plot 2.—147 pounds mixture plus 24 pounds Nitrate of Soda.

Plot 3.—147 pounds mixture plus 103 pounds dissolved phosphate rock.

Plot 4.—147 pounds mixture plus 20 pounds muriate of potash.

Plot 5.—195 pounds mixture.

Plot 6.—250 pounds commercial fertilizer.

It will be seen by the above that Plots 2, 3 and 4 received but three-fourths of the mixture as applied to Plot 5; the other fourth being supplied by doubling the amount of Nitrogen, phosphoric acid and potash respectively.

The yields of beets, percentage of sugar, and pounds of sugar per acre are given in the following table :

Plot.	Fertilizers.	Yield per acre. Pounds.	Per cent. sugar in beets.	Sugar per acre. Pounds.
1	Nothing.....	16,793	15.98	2,709
2	Excessive Nitrogen.....	25,098	16.23	4,083
3	Excessive Phosphoric Acid....	22,843	15.85	3,621
4	Excessive Potash.....	21,817	15.64	3,412
5	Normal Home Mixture.....	18,900	17.04	3,220
6	Commercial Fertilizer.....	17,740	15.66	2,778

These figures show decidedly in favor of increasing the Nitrogen content of the sugar-beet fertilizers. *Not only is the yield of beets greater, but the percentage of sugar is higher where an excessive amount of Nitrate of Soda is applied.* The marked difference in yield of sugar from the home mixed fertilizer over the commercial fertilizer suggests the possibility of Nitrate Nitrogen being superior to the form of Nitrogen found in the commercial fertilizer.

While no experiment comparing in equal quantities organic Nitrate and ammonia Nitrogen, the general results so far favor the Nitrate.

In the fertilizer experiment on page 130, the Nitrogen in the commercial fertilizer analyzing 2.24 per cent ammonia was undoubtedly of organic origin. The results from three years' experiments show a yield of 20 per cent more sugar from Nitrate Nitrogen than from the commercial fertilizer containing dried blood or some other organic Nitrogen.

### Nitrate Nitrogen vs. Ammonia Nitrogen.

This experiment has been in progress for three years. The results recorded on following page are from experiments in three different fields of the College Farm. In every case the potash and phosphoric acid applied on the compared plots were identical. The quantity of Nitrate of Soda and sulphate ammonia was in each case regulated according to the ammonia content of the two materials, so calculated that the same quantity of Nitrogen was applied in every case where results are compared.

The following is a fair comparison of Nitrate of Soda and sulphate ammonia as a source of Nitrogen for sugar-beets, and being the average result from five different experiments conducted for three years in succession, and showing a yield of over 11 per cent more sugar from the Nitrate than from the ammonia presents conclusive evidence of the superiority of the former.

CHARACTER OF SOIL.	NITRATE NITROGEN.			AMMONIA NITROGEN.		
	Yield per acre.	Per cent. sugar.	Sugar per acre.	Yield per acre.	Per cent. sugar.	Sugar per acre.
	Pounds.		Pounds.	Pounds.		Pounds.
1 Light sandy . . . . .	20,408	12.45	2,463	19,387	12.68	2,459
2 Clay loam . . . . .	20,136	13.19	2,656	16,412	12.44	2,041
3 Sandy loam (complete fertilizer)	16,479	14.09	2,323	15,899	14.19	2,255
4 Same as 3 plus (one ton lime)	18,789	13.43	2,524	15,572	13.19	2,176
5 Sandy loam (as single elements)	15,058	13.29	2,003	13,916	13.19	1,837
Average sugar per acre . . . . .	.....	.....	2,394	.....	.....	2,154



## Sugar-Beet Investigations in 1901.

By John W. Ames.

## Fertilizer Experiments at Neapolis, Ohio.

A series of plots containing 1-20 acre each, on light sandy soil at Neapolis, were treated with fertilizers for the purpose of showing the effect, if any, of phosphoric acid,

Table VII : FERTILIZER EXPERIMENTS ON BLACK SAND AT NEAPOLIS.

Plot No.	Fertilizer Applied per acre.	Date Analyzed.	Average wt. of beets—(grammes).	Sugar in beets—per ct.	Purity.	Yield per acre—pounds.	Increase per acre—pounds.	Gross sugar yield per acre—pounds.
1	None.	Oct. 2, 1901	358	13.5	88.2			
		" 15, 1901	350	14.9	86.2			
		" 29, 1901	268	16.6	88.2	8,700	.....	4,144
2	Acid phosphate, 160 pounds.	Oct. 2, 1901	217	15.4	88.5			
		" 15, 1901	373	15.8	89.6			
		" 29, 1901	237	18.4	87.2	8,740	260	1,608
3	Acid phosphate, 160 pounds. Potassium sulfate, 100 pounds.	Oct. 2, 1901	279	11.7	89.7			
		" 15, 1901	330	14.9	90.0			
		" 29, 1901	308	15.8	85.9	13,560	3,980	2,142
4	None.	Oct. 2, 1901	221	14.2	87.6			
		" 15, 1901	187	14.4	87.7			
		" 29, 1901	191	15.2	86.4	9,360	.....	1,422
5	Acid phosphate, 160 pounds. Nitrate of Soda* 160 pounds. Potassium sulfate, 100 pounds.	Oct. 2, 1901	327	15.0	89.8			
		" 15, 1901	411	13.9	84.9			
		" 29, 1901	162	16.6	84.3	17,100	8,070	2,838

\* Nitrogen applied in form of Nitrate of Soda.

potash and Nitrogen on the quality of beets and yield per acre. Acid phosphate, potassium sulfate, potassium chlorid, *Nitrate of Soda*, tankage and barnyard manure were used as carriers of the phosphoric acid, potash and Nitrogen. The same variety of seed, Original Kleinwanzlebener, was planted on all the plots.

### Results on Black Sand.

*More satisfactory results* were obtained from the fertilizer tests on black sand, the increase of yield of the fertilized plots over the unfertilized being very decided. The test included a series of five plots, the first and fourth being left unfertilized. The results shown in Table VII, page 72, set forth the interesting facts that acid phosphate alone increased the yield 260 pounds to the acre; the combination of phosphoric acid and potash shows better results, by increasing the yield 3,980 pounds per acre; the combination of phosphoric acid, potash and *Nitrogen* shows the best results, giving an increase of 8,070 pounds per acre.

## Nebraska Agricultural Experiment Station.

Extract from Bulletin No. 73.

Table IV.—EFFECT OF EACH CLASS OF FERTILIZERS.

FERTILIZERS.	Yield per acre in tons.	Sugar in juice per cent.	Purity of juice per cent.
Plots having potash.....	11.6	12.7	81.4
Plots having Nitrate.....	11.7	13.0	81.8
Plots having phosphate.....	11.7	12.7	81.2
Plots not fertilized.....	11.1	12.6	81.3

# The Progress of the Beet Sugar Industry in America.

Nitrate of  
Soda for  
Sugar-Beets

From Report No. 80,

U. S. Department of Agriculture.

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Page 175.

The work of Professor C. O. Townsend, of the Bureau of Plant Industry of the United States Department of Agriculture, which has recently been published in Secretary Wilson's Report for the United States Department of Agriculture, concerning the use of Nitrate of Soda on sugar-beets is of great interest and is as follows :

“ Nitrate of Soda has a decided effect in increasing the value of beets per acre. This experiment has been repeated several times with similar results under varying conditions. It seems, therefore, that Nitrate of Soda is beneficial as a fertilizer for sugar-beets under ordinary circumstances. A little better results were obtained by putting the Nitrate on in two applications, as shown in plat 4, although when 300 pounds of Nitrate were applied at one time the results were almost as good. The cost of the 300 pounds of Nitrate, including its application, was approximately \$9.00, so that in all cases where Nitrate was used a decided financial gain resulted. It should be noted, also, that the Nitrate did not apparently affect the sugar content nor the purity of the beets. In a few cases where larger quantities of Nitrate were used the results were not appreciably better than when only 300 pounds per acre were applied. Whether or not this is a general rule can be determined only by repeated experiments.”

The great and growing interest now taken in the subject of raising beet sugar in this country makes the use of Nitrate of Soda on this crop of special interest, for it is only by the judicious use of this fertilizer that we can hope to compete with the best growers of Europe who have long profited by its use.

Nitrate should be used only in connection with superphosphate and potash, and should be applied early in the growth of the beet—as soon after they come up the better; 200 to 300 pounds of Nitrate per acre is about the quantity that should be used. About 300 pounds of superphosphate and 100 pounds of sulphate of potash should be applied per acre before sowing the seed.

J. E. W. Tracy, of the Bureau of Plant Industry of the U. S. Department of Agriculture, says in Farmers' Bulletin No. 251 :

“It is absolutely essential to success that we secure the best quality of seed, and past experience has conclusively shown that we cannot depend upon doing so from abroad. We must raise it ourselves, and in such a careful, *scientific manner* that it will not only be of the best quality, but will have such characteristics as will make it adapted to the particular needs and requirements of the locality where it is to be sown. Seed raised on a particular soil and under certain climatic conditions may not be best suited for planting in like soils and under similar climatic conditions; in fact, very often it is not. Seed from comparatively poor soil may do best on rich soil, or that raised in the East may do best when sown in the West. Only study and personal experience on the part of each factory manager can determine what seed is best suited for the conditions in his region.”

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## Fertilizers for the Sugar-Beet.

“Professor Schneidewind, the German beet expert, has made extensive experiments with fertilizers for beets and he has come to the conclusion that the views of the different experts in regard to the value of these fertilizers which are best suited to beets can never be considered as correct, because the plant foods at the disposal of the root have a very different effect in different surroundings, and that it must remain largely for the individual farmer to give each suggestion a fair trial and then draw his own conclusions. The experiments by Schneidewind show that a surface application, Top-Dressing, of Nitrate of Soda (saltpeter) is better suited to beets than any other form of nitric fertilizer, *and very much more satisfactory.*”

—From *The American Sugar Industry*, 1906.

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## Nitrate of Soda as a Fertilizer for Beets.

Mr. E. S. Bumstead, President of the State Beet Growers' Association, of Colorado, has stated that “At Sugar City, near Rocky Ford, beet growers began using *Nitrate of Soda as a fertilizer three years ago. This was obtained from Chili, South America, and the very first experiment therewith proved so beneficial that it has been in use ever since.*

*“Two hundred and thirty-five tons were tried first. The indications were from the outset that just the right thing had been discovered, and my opinion is that this will eventually become a great commercial article. It is reliably told me that 100 pounds of the soda will increase beet tonnage from 2½ to 3½ tons per acre.*

“With this in view, it can be readily seen that such a fertilizer is not only practical, but quite profitable. This is another case in which science is aiding nature, but science must be good for something.”



# Experiments with Nitrate of Soda.

## SUGAR BEETS.



No  
Fertilizer



Phosphoric Acid  
and Potash

By Dr. Paul Wagner.



Potash and  
 $\frac{1}{4}$  oz Nitrate

# Experiments with Nitrate of Soda.

## SUGAR BEETS.

Fertilized with Phosphoric Acid, Potash

AND



$\frac{1}{4}$  oz. Nitrate.



$\frac{1}{2}$  oz. Nitrate

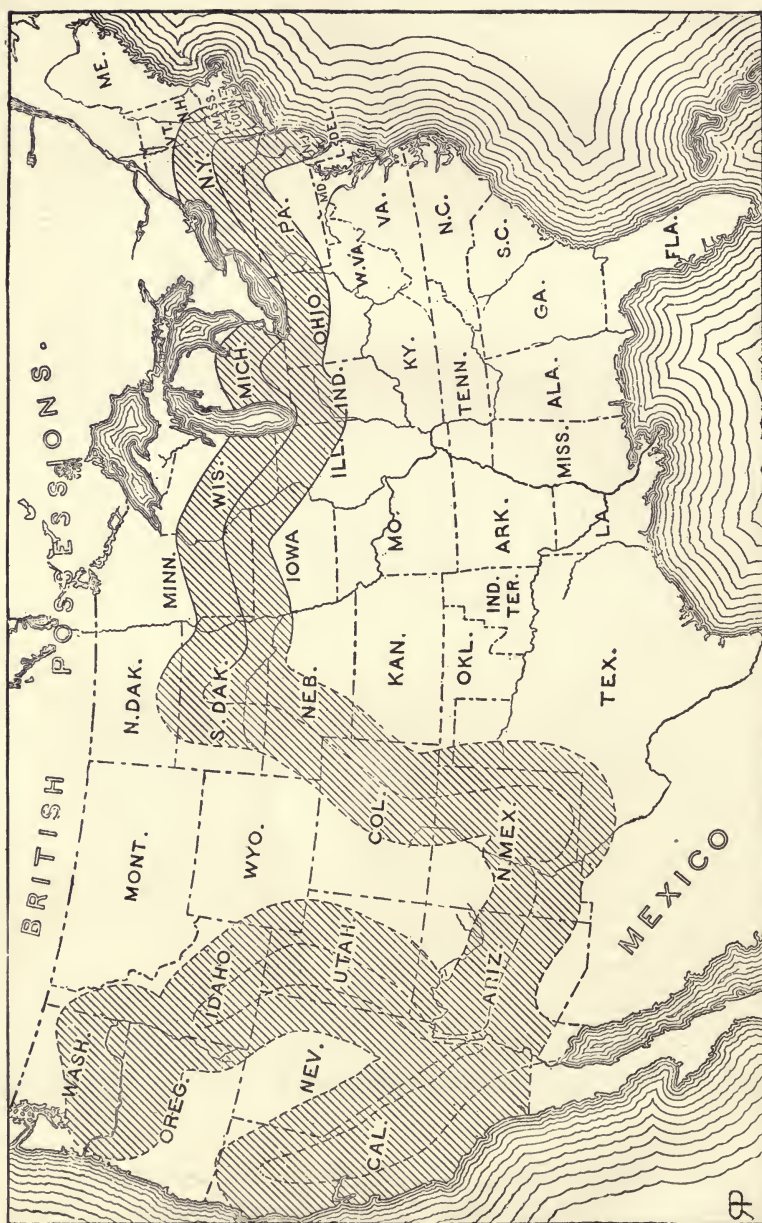


$\frac{3}{4}$  oz. Nitrate.

From 150 to 300 lbs. Nitrate of Soda per acre is applied in one or more dressings.

By Dr. Paul Wagner.

In the experiments with sugar-beets, it will be noticed that the addition of a ration of phosphoric acid and potash to the soil, without Nitrate, actually reduced the yield of sugar-beets. Then as the quantity of Nitrate was increased, the yield of sugar-beets was correspondingly increased.



Map showing temperature zone in which the sugar-beet attains its greatest perfection.—From *Farmer's Bulletin*, No. 52,  
U. S. Department of Agriculture.

# Table Showing Prices of Nitrate of Soda on the Ammoniate Basis.

Nitrate of  
Soda for  
Sugar-Beets

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Figured on Basis of 380 Pounds Ammonia in One  
Ton of Nitrate of Soda.

Cost per Cwt. of Nitrate.	Equivalent Cost Ammonia per Ton unit.	Cost per ton of Nitrate.	Cost Ammonia per lb. as Nitrate.	Equivalent Cost of Nitrogen per lb.
\$2.00	\$2.10	\$40.00	\$0.105	\$0.128
2.05	2.16	41.00	0.108	0.131
2.10	2.21	42.00	0.111	0.134
2.15	2.26	43.00	0.113	0.137
2.20	2.31	44.00	0.116	0.140
2.25	2.37	45.00	0.118	0.144
2.30	2.42	46.00	0.121	0.147
2.35	2.47	47.00	0.124	0.150
2.40	2.53	48.00	0.126	0.153
2.45	2.58	49.00	0.129	0.156
2.50	2.63	50.00	0.132	0.159
2.55	2.68	51.00	0.134	0.162
2.60	2.73	52.00	0.137	0.165
2.65	2.78	53.00	0.140	0.168
2.70	2.83	54.00	0.143	0.171
2.75	2.88	55.00	0.146	0.174
2.80	2.93	56.00	0.149	0.177
2.85	2.98	57.00	0.152	0.180
2.90	3.03	58.00	0.155	0.183
2.95	3.08	59.00	0.158	0.186
3.00	3.13	60.00	0.160	0.189

This table enables one to compare commercial quotations on ammoniates with accuracy. The figures themselves are not quotations in any sense of the word, and all the figures of the table refer only to one grade of Nitrate of Soda, namely: that containing 15.65 per cent. of Nitrogen, equivalent to 19.00 per cent. of ammonia. It is prepared merely in order that purchasers may compare the price of Nitrate of Soda, which is always quoted by the hundred pounds, with other ammoniates, which are quoted by the ton unit. In the first column, therefore, are given the prices per hundred weight of Nitrate of Soda; in the second



column, the equivalent price of the ammonia per ton unit; in the third column, the corresponding prices per ton; in the fourth column, the cost of the contained ammonia per pound, a figure which is always discussed, but almost never explained in Station Bulletins, and in the fifth column are given the corresponding prices of the cost of the Nitrogen per pound, a figure also much discussed, but not always explained in Bulletins. The important figures to remember are the price per hundred weight, the price per ton and the equivalent price of the ammonia in the Nitrate per *ton unit*. *The table is prepared to cover fluctuations in price running from two dollars per hundred, to three dollars per hundred; or from forty dollars to sixty dollars per ton.*

**Increased Yield per Acre of Crops receiving Nitrate  
at the rate of 100 pounds to the Acre  
over those receiving none.**

Barley	.	.	.	.	.	.	400 pounds of grain.
Corn	.	.	.	.	.	.	280 pounds of grain.
Oats	.	.	.	.	.	.	400 pounds of grain.
Rye	.	.	.	.	.	.	300 pounds of grain.
Wheat	.	.	.	.	.	.	300 pounds of grain.
Potatoes	.	.	.	.	.	.	3,600 pounds of tubers.
Hay	.	.	.	.	.	.	1,000 pounds, barn-cured.
Cotton	.	.	.	.	.	.	500 pounds seed-cotton.
Sugar-Beets	.	.	.	.	.	.	4,000 pounds of tubers.
Beets	.	.	.	.	.	.	4,000 pounds of tubers.
Sweet Potatoes	.	.	.	.	.	.	3,900 pounds of tubers.
Cabbages	.	.	.	.	.	.	6,100 pounds.
Carrots	.	.	.	.	.	.	7,800 pounds.
Onions	.	.	.	.	.	.	1,800 pounds.
Turnips	.	.	.	.	.	.	37 per cent.
Strawberries	.	.	.	.	.	.	200 quarts.
Asparagus	.	.	.	.	.	.	100 bunches.
Tomatoes	.	.	.	.	.	.	100 baskets.
Celery	.	.	.	.	.	.	30 per cent.



## General Directions for the Use of Nitrate of Soda on Staple Crops.

Nitrate of  
Soda for  
Sugar-Beets

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The use of Nitrate of Soda *alone* is never recommended, except at the rate of not more than one hundred pounds to the acre. *It may be thus safely and profitably used without other fertilizers.* It may be applied at this rate as a Top-Dressing in the Spring of the year, as soon as vegetation begins to turn green; or, in other words, as soon as the crops begin new growth. At this rate very satisfactory results are usually obtained without the use of any other fertilizer, and the Soda residual, after the Nitrogenous Ammoniate Food of this chemical is used up by the plant, has a perceptible effect in sweetening sour land.

In most of our Grass experiments where Nitrate was used alone at the rate of but One Hundred Pounds per acre, not only was the Aftermath, or Rowen, much improved, but in the subsequent seasons, with nothing applied to the plots, a decidedly marked effect was noticed, even on old meadows. This speaks very well indeed for Nitrate of Soda not leaching out of the soil. The readily soluble elements are the readily available elements. The natural capillarity of soils doubtless is, in most instances, a powerful factor in retaining all readily soluble elements of fertility.

If this were not so, all the fertility of the world in our humid regions would, in a season or two, run into the ocean, and be permanently lost.

This is mentioned on account of certain critics having taken the trouble to object to the use of Nitrate on the grounds that it would leach away. A case is yet to be seen where the after-effect of Nitrate is not distinguishable, and, in certain cases, such effects have been most marked.

When it is desired to use a larger amount than one hundred pounds per acre of Nitrate of Soda as a Top-Dressing, or in any other way, there should be present some form of Phosphatic and Potassic Plant Food, and we recommend not less than two hundred and fifty pounds of either Acid Phosphate or fine ground Raw Rock, and two hundred and fifty pounds of some high-grade Potash Salt, preferably the Sulphate, or wood ashes in twice this quantity. *A much larger amount than one hundred pounds of Nitrate per acre, when used alone on staple crops, is generally sure to give an*

Nitrate of Soda for Sugar-Beets *unprofitable and unbalanced food ration to the plant.* For Market Gardening Crops, Hops or Sugar-Beets, however, somewhat more may be used alone.

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When the above amounts of Phosphatic and Potassic Fertilizers are used, as much as three hundred pounds of Nitrate of Soda may be applied with profit. In applying Nitrate in any ration it is desirable to mix it with an equal quantity of land plaster or fine, dry loam or sand.

If you have any reason to suspect adulteration of the Nitrate you may buy, send several pounds of it to your Experiment Station for analysis, giving date of purchase, full name and address of agent, and of the Company which the seller represents.

Generally on the Pacific Coast Nitrate may be applied as a Top-Dressing after the heavy Spring rains are over, but before crops attain much of a start.

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